

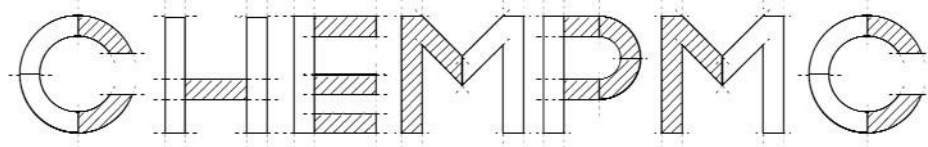
Polypropylene Market Overview

PREPARED FOR THE FLEXIBLE PACKAGING
ASSOCIATION

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1. Executive Summary

This report complements the presentation conducted by Esteban Sagel at FPA's FlexForward Conference in Kansas City on October 12, 2023.

North America's polypropylene market is not doing great. Most end uses of polypropylene are decreasing in the region, resulting in demand losses in 2022 and 2023. The main driver of this trend are changes in consumers' behaviors, as the COVID pandemic comes to an end. Exports of polypropylene are the only saving grace for regional producers, showing growth in 2022 and 2023. Proximity and similar cost dynamics make the markets closest to North America the preferred destination for those exports. Nevertheless, the increase in exports has not been enough to compensate for the fall in domestic demand.

China is no longer the market of last resort for global polypropylene producers. The country's polypropylene deficits are declining, as it becomes increasingly self-sufficient. The fact that expected demand growth in the country did not materialize also had an impact. As a result, a large amount of expected import demand from China has disappeared. The overall consequence of these factors is that the world has moved to a polypropylene oversupply situation.

Between 2022 and 2023, polypropylene capacity in North America expanded by one million metric tons. At the same time, production in the region declined. The weak demand situation in the region is the key driver for the negative production trends. One interesting development is that investments in environmentally friendly production are on the rise. This is happening despite the negative demand trends in the region.

Imports of polypropylene into North America are declining. We venture to say that this is a move in the wrong direction. Prices in the region are much higher than prices elsewhere, and imports are one of the ways that those big price differentials can be reduced.

Oil prices remain volatile but are in general trending higher. Higher oil prices are increasing the price floor for propylene and polypropylene. Additionally, events that affect supplies are impacting propylene and polypropylene prices, creating a lot of short-term price volatility. Of particular interest for converters are turnarounds, new plants, and weather events, which can all potentially affect the short-term trends in prices.

Producer margins in the region are trending lower. As a result, we expect producers will try to stem the underlying negative trend in prices. Nevertheless, we expect short-term price volatility, but a long-term (12 to 24 months) trend for prices to move and remain low.

2. 2023: A boring Year?

One of the concerns I had as I started preparing this year's presentation was that I wasn't exactly sure what should talk about. After the excitement of the first two years of the decade, 2023 appeared to be a "boring year".

First, the COVID pandemic was officially over. In May of this year, the Centers for Disease Control and Prevention officially [ended the COVID-19 Public Health Emergency Declaration](#). Irrespective of the official position, the public had for the most part moved on. The number of [positive tests](#) increased tremendously between June and August of this year, but no one seemed to care. We were finally free to roam around, and those who could afford it did it with gusto. Air travel demand in the U.S. was up 12% in July versus the same month last year, and through July [total travel expense was up 4.1% year-to-date](#). The U.S. consumers have transitioned away from pandemic-era consumption (remember the toilet paper craze?) and focused on making up for the lost time with experiences and travel.

On the weather front, it has been a much better year than expected. This is something puzzling to say, when considering that the 2023 hurricane season has been quite active. Through October 13, the season had produced 18 named storms and 89 named storm days, [which is the 5th most days since 1966](#). Also, in late January/early February, a strong winter storm brought [0.75 inches of ice to Central Texas](#) and the Hill Country, which paralyzed many cities across the northern half of the state. However, from our industry's perspective, the storms that really count are those that impact the U.S. Gulf Coast, where 90% of the polymer production facilities are concentrated. Only tropical storm Harold affected the Gulf Coast of Texas, but it did in the southernmost part of the state, where no facilities were impacted.

The economy in the country keeps chugging along, with the feared recession not yet making its appearance. Inflation has been somewhat tamed, and U.S. job growth continues strongly. Employers [added 336,000 jobs in September](#), despite high interest rates and inflation. It's like companies have grown tired of recession-forecasters "crying wolf".

Finally, we are still far from the next big election cycle, and there have been no major developments in the war against plastics.

So, overall, not much exciting stuff happening, and therefore my impression of 2023 being a "boring year".

But is it really a boring year?

When we drill down into the polypropylene industry, things seem a lot more interesting than the lack of external events may seem to indicate. Why do we say that? Here are some observations:

- Polypropylene demand has fallen again this year. To date, demand for polypropylene is down 9% versus its level last year, which was already lower than its level in 2021.
- A symptom (or consequence) of this decline in demand: converter facilities closing in North America.
- Polypropylene production in the region decreased by 10% in 2022 and 2% so far this year, even though we added two new production plants in North America.
- Even though prices in the region are exceedingly high, export out of the U.S. and Canada have increased 40% versus last year.
- China's polypropylene imports have decreased by 2 million metric tons since 2020, and the country's exports have expanded by 850 thousand tons during the same period.
- Polypropylene prices are doing the roller-coaster thing – up some months, down some others, and remain higher than prices in Asia.
- Bio-based polypropylene production facilities are being analyzed for the region, despite the negative demand growth profile.

So, this “uneventful” year is seeing several disparate forces in play, that are not easy to explain and that are pulling the polypropylene industry in different directions.

Therefore, what we will do is spend some time analyzing the different pieces of this puzzle. We will try to understand them and bring them together into a cohesive picture that may allow us to venture where the industry may be headed, particularly from a pricing perspective.

Let's get started.

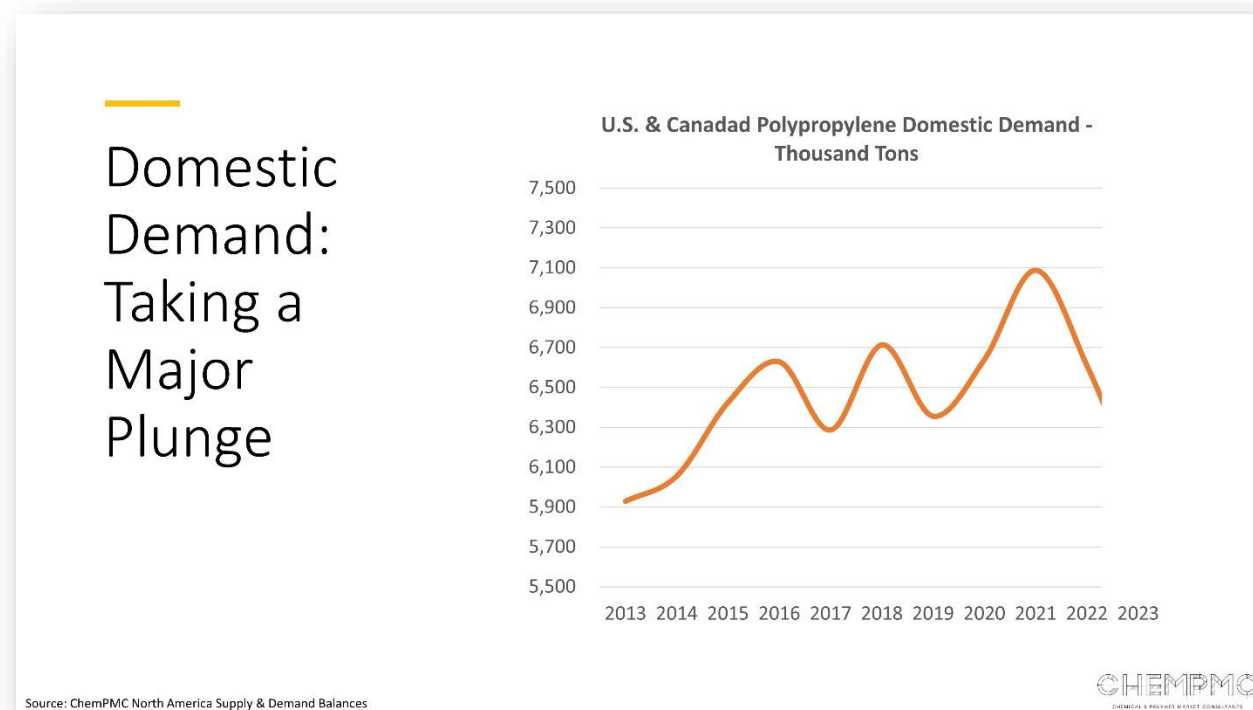
3. First piece of the puzzle: Demand

3.1 Domestic Demand

Demand in North America has taken a major turn. In 2021, polypropylene domestic demand in the U.S. and Canada reached almost 7.1 million metric tons, its highest level in the last 10 years. At 19 kg per person, it was very close to the per capita demand for high density polyethylene, the most consumed polymer in the region. Demand for

polypropylene had increased by a 2% annual average during the previous decade. However, 2022 saw a huge decline in demand. In just that year, we estimate that domestic demand decreased by 6.8%, pretty much erasing all the growth that had taken place in 2021 (Figure 1).

Figure 1 - North American (U.S. + Canada) Polypropylene Domestic Demand



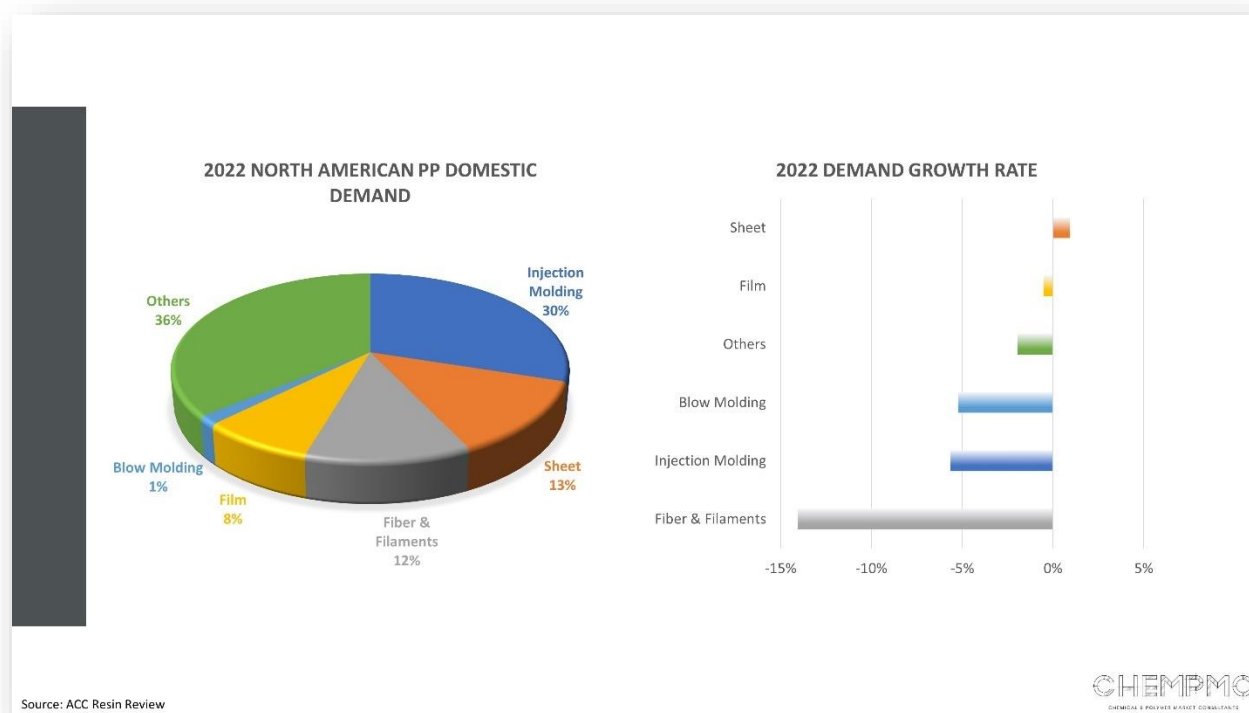
Polypropylene is a versatile material that goes into many applications. Injection molding, sheet, and fiber & filaments are the largest demand categories for polypropylene (Figure 2). Film is the third largest category of demand, with an 8% share. Except for sheet, all demand categories saw declines in 2022.

Fibers and filaments, the third largest demand segment, saw the largest decline in demand, both from a percentage and volume standpoint. This may be related to a reduction in construction activity in the region, since fibers for carpet facing and carpet backing are an important component of this segment. Specifically, residential construction

spending in the United States, that had increased steadily between February 2021 and May 2022, saw a 12% decline between May and December of last year¹.

Injection molding, the largest segment of demand, saw the second biggest decline in demand in terms of volume and percentage. The end uses that drove this decline include appliances, furniture, and housewares, with some rigid packaging categories also declining².

Figure 2 - 2022 U.S. & Canada Demand Breakdown and Growth Rates



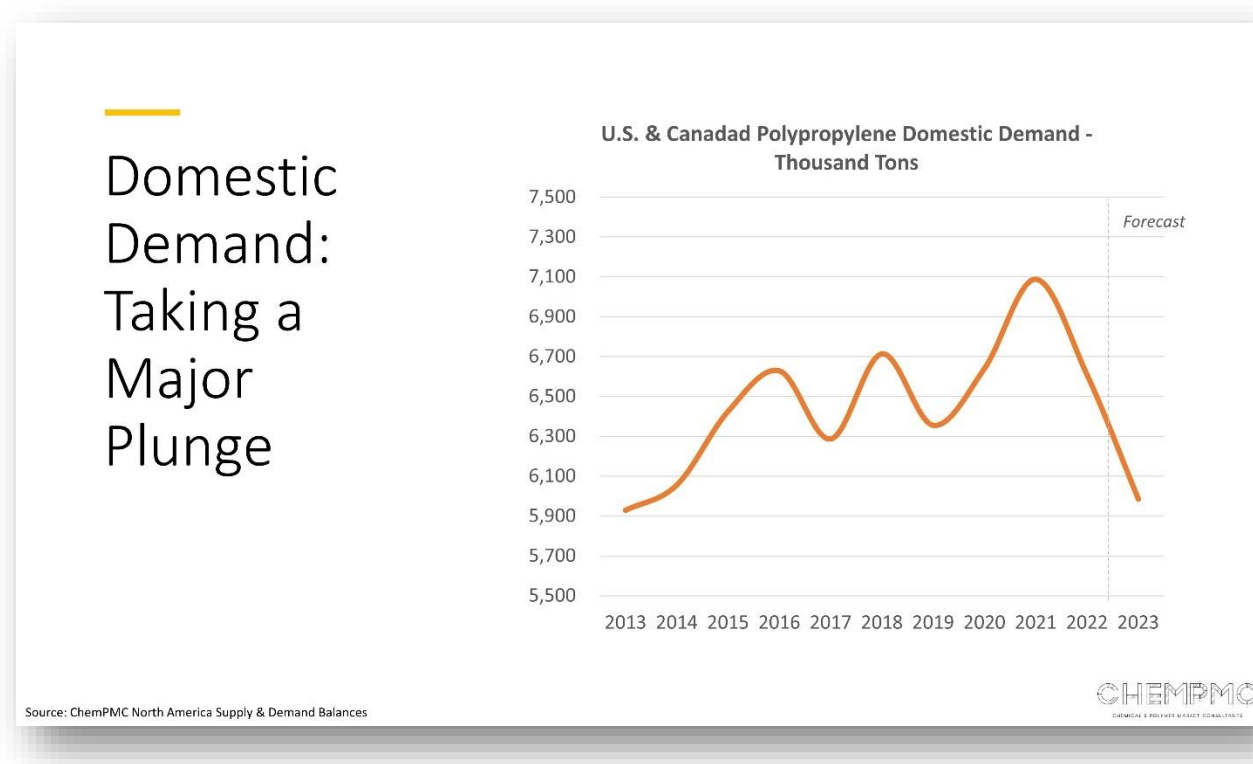
Unfortunately, this negative trend has continued in 2023. We estimate that, through July, domestic demand has declined by 9%. If the trend does not change, by the end of the year the North American market would have lost as much as 600 thousand tons of demand in a single year. In just two years, the region would have lost one million metric tons of demand – the equivalent of two world scale plants of polypropylene!

¹ <https://fred.stlouisfed.org/series/TLRESCONS>

² American Chemistry Council's Resin Review- 2023

This is a tough business environment, whether you are a polypropylene producer or end user. Unfortunately, we are seeing the consequences of the tougher market conditions. In May, Berry Global announced the closure of 15 facilities, [a number that got expanded to 20 facilities](#) during the company's Q3 earnings webcast. But they are not the only ones; Dart Containers, Genpak, Novolex and Sonoco, to name a few, have also announced plant closures this year³.

Figure 3 - U.S. & Canada Domestic Demand Trends



3.2 Economic Headwinds

What may be the key driver of these trends? Without a doubt, changes in household consumption in the region are a key factor. Figure 4 shows the quarterly growth rate for U.S. personal consumption expenditures. The chart on the left shows a couple of important facts. First, personal consumption of durable and non-durable goods as well as services slowed down in the second quarter of the year. Second, we can also see how

³ <https://www.plasticsnews.com/news/novolex-closing-flexible-packaging-and-films-plant>, <https://www.plasticsnews.com/news/sonoco-closing-california-thermoforming-plant-laying-more-300>, <https://www.packagingdive.com/news/packaging-manufacturing-layoffs-closures-q1-2023/646249/>

the demand for durable and non-durable goods has been steadily slowing down, after expanding tremendously at the end of 2020. Lastly, another trend that can be observed is how consumers have shifted their spending from goods to services.

In a [July 31st report to the Treasury Borrowing Advisory Committee](#), the acting Secretary of Economic Policy, Eric Van Nostrand, indicated that the spending growth in services was largely due to increases in housing and utilities, health care, financial services, and insurance costs. In contrast, consumption of food services and accommodations have been trending lower. The second chart in Figure 4 shows exactly that. The trend in consumption of food consumption as well as food services and accommodations has decelerated tremendously since late 2020/early 2021, reaching almost zero growth in the second quarter of this year.

Figure 4 - Quarterly Growth Rate, U.S. Personal Consumption Expenditures



When we look at it all together, growth in consumption of durable and non-durable goods has decelerated, and consumption of food and food services and accommodations has

also decreased. These trends don't bode well for our industry, which depends on healthy and strong consumer demand.

And that's not all, There are other clouds on the economic horizon. The first cloud is related to inflation and interest rates. Even though inflation in the U.S. has declined recently, it is [still higher than the Federal Reserve's target](#). The question is what the Fed would do going forward. One of its options is to continue to expand interest rates, which carries the risk of pushing the country into a recession. There is no consensus on whether additional interest rate hikes will come. The fact that [bond rates are increasing](#) may be doing the Fed's work of slowing the economy, without the need of further rate increases.

Inflation's impact on consumers is also increasing pressure on wages. Actions like autoworkers and Kaiser-Permanente strikes, as well as wage gains in other union contracts, may lead to higher worker pay throughout the economy. This may contribute to further inflationary pressures in the U.S.

The political polarization could become another factor that would negatively affect the economy. In September, the U.S. barely avoided a government shutdown. But, without a new speaker in the House, we may see a shutdown taking place before Thanksgiving. This in turn may result in modest losses in gross domestic product.

Additional economic clouds include the resumption of student loan payments, which may pull \$100 billion out of consumers' pockets, rising oil prices, and stagnating global economic growth⁴. All these clouds may threaten the country's ability to pull a soft landing for the economy.

3.3 Bright Demand Spot: Exports

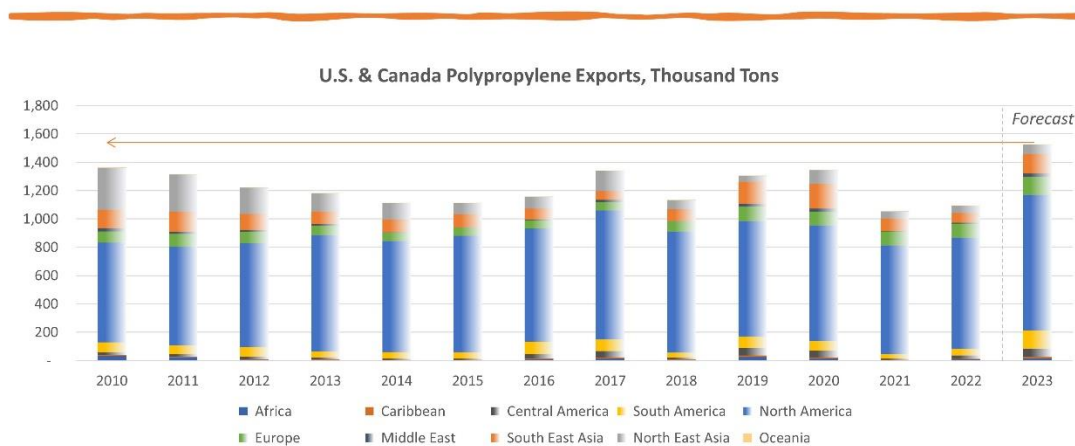
After all the bad news about domestic demand and the economy, there is at least one positive thing to report, particularly for those of you that are polypropylene producers. Exports, which for a long time have been a disappointing component of the demand profile in the region, have taken off.

In 2022, polypropylene exports expanded by 4%. Through July of this year, exports have expanded by as much as 40%. If the trend continues through the end of the year, exports will break the 1.4 million metric ton barrier, reaching their highest level since at least 2010.

⁴ <https://www.bloomberg.com/news/newsletters/2023-09-27/world-economy-latest-risks-to-us-soft-landing-are-piling-up-again>

Figure 5 - U.S. & Canada Polypropylene Exports

Bright Demand Spot: Exports



Source: ITC Trade Map, ChemPMC Estimates

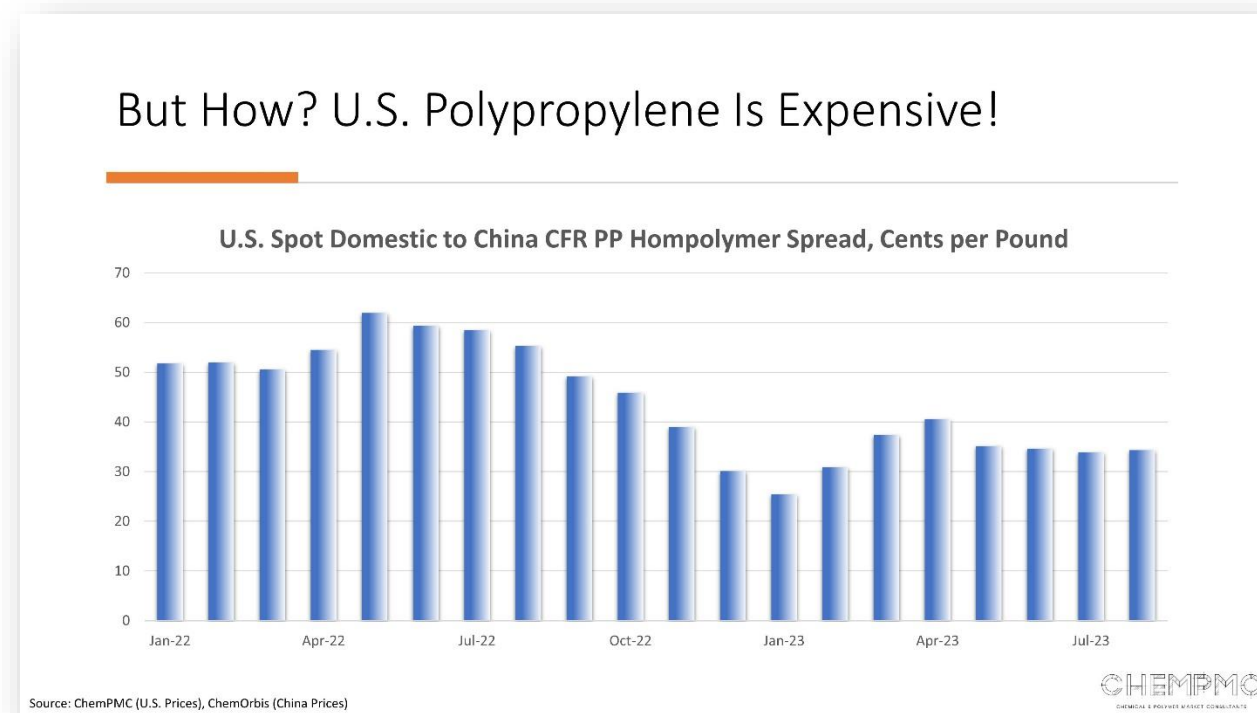
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This positive trend is puzzling, if we consider how much higher polypropylene prices are in North America versus other regions.

To show you what we mean, Figure 6 presents the spread between U.S. spot prices and prices in China. The spread has come down from the extremely high levels it attained at the height of the pandemic. That said, it remains at more than 30 cents per pound.

Therefore, how did U.S. producers manage to increase exports by 40%, if the price for polypropylene in the region is one of the (if not *the*) highest prices in the world?

Figure 6 - U.S. Spot to China CFR Polypropylene Homopolymer Price Spread



To understand this, it helps to analyze where exports are growing. Figure 7 compares the 2022 exports with our forecast for 2023 exports, which is based on the January to July export growth rate for each region.

As you can see from the table, exports to the American continent represent the bulk of the growth in exports out of the U.S. and Canada. Specifically, 70% of the 433 thousand tons of additional exports this year would be destined to a country in the Americas. Most of the growth in volume will take place in exports into North America (essentially Mexico), but South and Central America will also see important increases in export volumes.

Figure 7 - U.S. & Canada Polypropylene Exports

| US & Canada PP Exports (KT) | | | | |
|--|-------------|------------------------|---------------|----------|
| | 2022 | 2023 (FCST) | Growth | |
| | | | KT | % |
| Africa | 6 | 13 | 7 | 123% |
| Caribbean | 5 | 11 | 6 | 116% |
| Central America | 25 | 61 | 36 | 142% |
| South America | 45 | 127 | 82 | 181% |
| North America | 786 | 957 | 171 | 22% |
| Europe | 100 | 127 | 27 | 28% |
| Middle East | 6 | 24 | 18 | 300% |
| South East Asia | 69 | 139 | 70 | 102% |
| North East Asia | 51 | 67 | 15 | 30% |
| Oceania | 0 | 1 | 1 | 633% |
| Total | 1,093 | 1,526 | 433 | 40% |

The fact that most of the growth in export volumes is taking place in the Americas makes sense when we consider how the whole continent polypropylene value chain is connected. Latin America is a net importer of propylene. The region does not produce enough propylene to meet its polypropylene production needs. As you can see in Figure 8, as much as 80% of the propylene imported into the region is sourced from the United States. Besides this, propylene prices in the region are typically established using U.S. propylene price references. There are no local price indexes, so Latin American propylene producers use the U.S. polymer grade propylene price as the basis for their contracts. Therefore, the polypropylene industry in Latin America is impacted by the same cost drivers as those in North America.

As a result, cost and price dynamics for polypropylene in North and South America are closely related. This facilitates exports of U.S. and Canadian polypropylene to the region, as they would be competing in a region with similar cost and price dynamics as that of the U.S. Therefore, proximity and cost dynamics help explain how Latin America is the key destination for increased exports out of North America.

Figure 8 - Latin America Propylene Imports

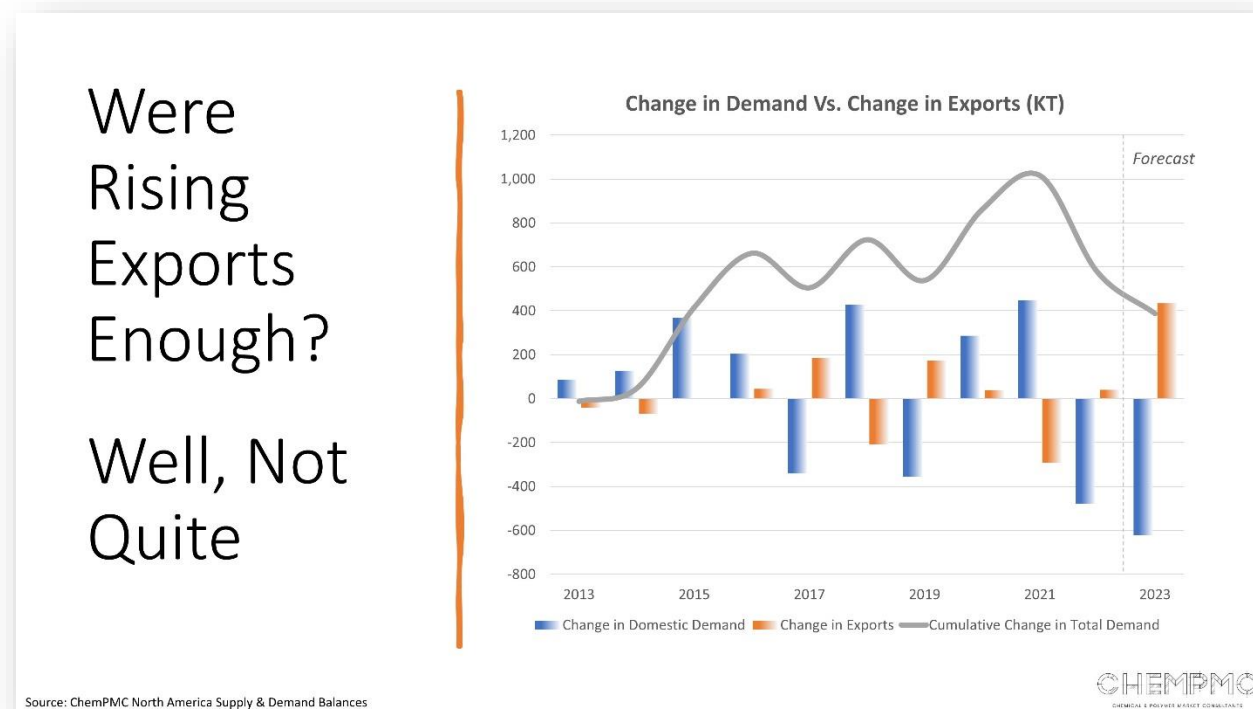


So, we have a declining domestic demand for polypropylene in North America, but a rising export profile. The question you may be asking is whether the increase in exports was enough to compensate for the drop in demand.

Figure 9 shows the annual change in demand versus change in exports over the last 10 years. As we add those on a cumulative basis, we can see how total demand (Domestic Demand + Exports) has evolved over time.

The figure shows that, in 2023, we expect that the rise in exports will help stem the steepness of the decline in total demand, but will not be enough to keep the total demand change for the year in the positive.

Figure 9 - Change in Demand Vs. Change in Exports in North America



3.4 Asia: Demand Dynamics in Flux

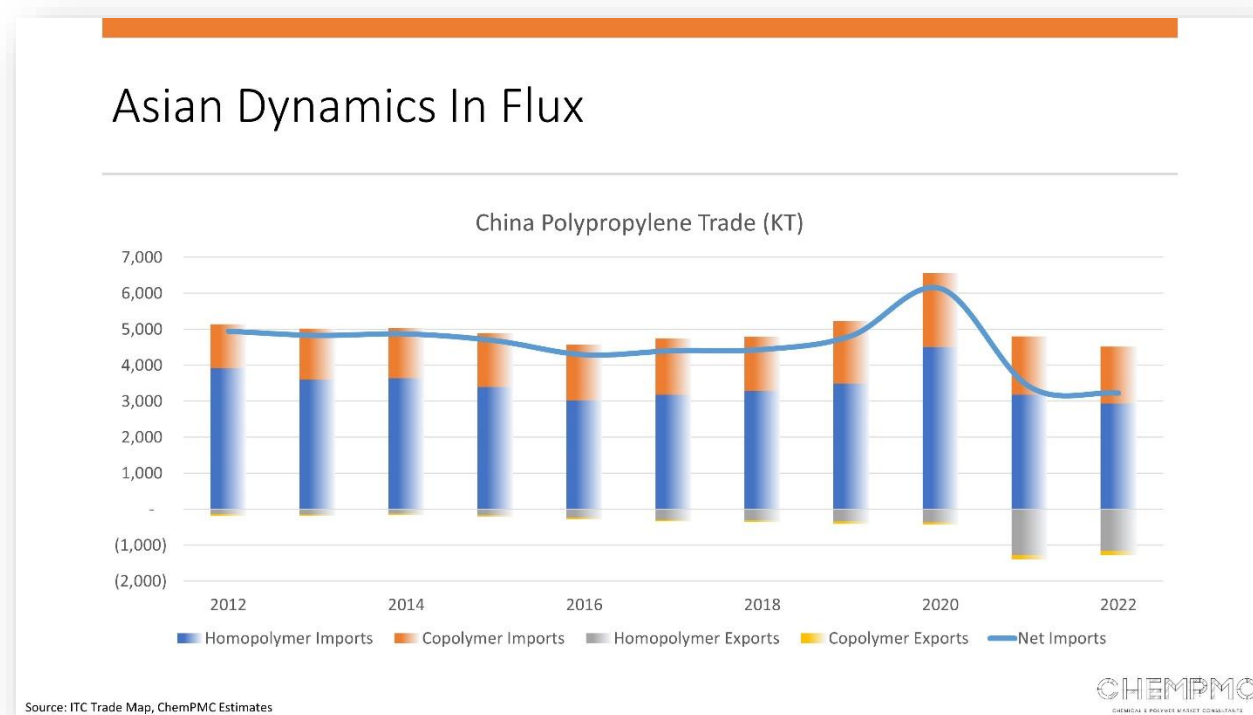
Finally, we cannot talk about demand without touching the situation in Asia, and particularly in China. The country had historically been considered the market of last resort for polymer producers globally. No matter what project companies were investing in, China was one of the key markets being considered. The premise was that the Chinese market, with its large population, state-driven capitalist system, low wages, and export-oriented economy, would be in need for ever-increasing quantities of polymers.

However, the equation has been changing. First, from a domestic supply point of view, China has been heavily investing in petrochemical production capacity. Geopolitics, to some extent, has been a driver for this move. In an increasingly polarized world, where globalization is faltering, the Chinese State wanted to ensure it had enough domestic supplies to feed its own markets. In the case of polypropylene, [it is estimated that the country is well over 90% self-sufficient](#). This means that domestic polypropylene production can serve 90% of the polypropylene demand in the country.

The other factor that's changing the equation is that the expected ever-increasing and rapid growth in demand has failed to materialize. Again, the breakdown of globalization, first motivated by geopolitical issues between China and the U.S., and then highlighted by the logistical issues that the COVID pandemic brought into light, has put a damp on demand growth in the country. It also doesn't help that domestic demand (for goods and services) has failed to meet the wishes from China's Communist party, and has not been able to compensate the lower growth in export demand for Chinese products.

The net result of an increased self-reliance and lower demand growth rates in China? A decrease in net imports

Figure 10 - China Polypropylene Trade



Since 2020, China's polypropylene imports have decreased by 2 million metric tons. Not only that, but the country's PP exports also have expanded by 850 thousand tons during the same period. Put it all together, and it roughly equals to the loss of an equivalent of 6 world-scale polypropylene plants of demand for polypropylene exporters around the world.

Only considering North America and China, in the last two years we have “lost” the equivalent of 8 world scale polypropylene plants of demand or of opportunities for exports. This places the global polypropylene industry in an oversupply situation.

3.5 Demand – So what?

Ok, that was a lot.

So, of all of that, what are the most relevant message(s) that you should remember?

First, you know now that domestic demand for polypropylene in North America is not doing great. Most end uses of polypropylene are decreasing in the region. This is mainly due to changes in consumers’ behaviors, related to where and in what they are spending their hard-earned money.

Exports of polypropylene are the only saving grace for regional producers. The markets closest to North America are the preferred destination for exports. Nevertheless, the increase in exports is not expected to be enough to compensate for the fall in domestic demand.

China’s polypropylene deficits are declining. The Asian country is becoming more self-sufficient. In the process, a large amount of expected import demand from that country is disappearing.

The overall consequence of all these factors? The world is in a polypropylene oversupply situation.

What’s next? Let’s talk about supplies.

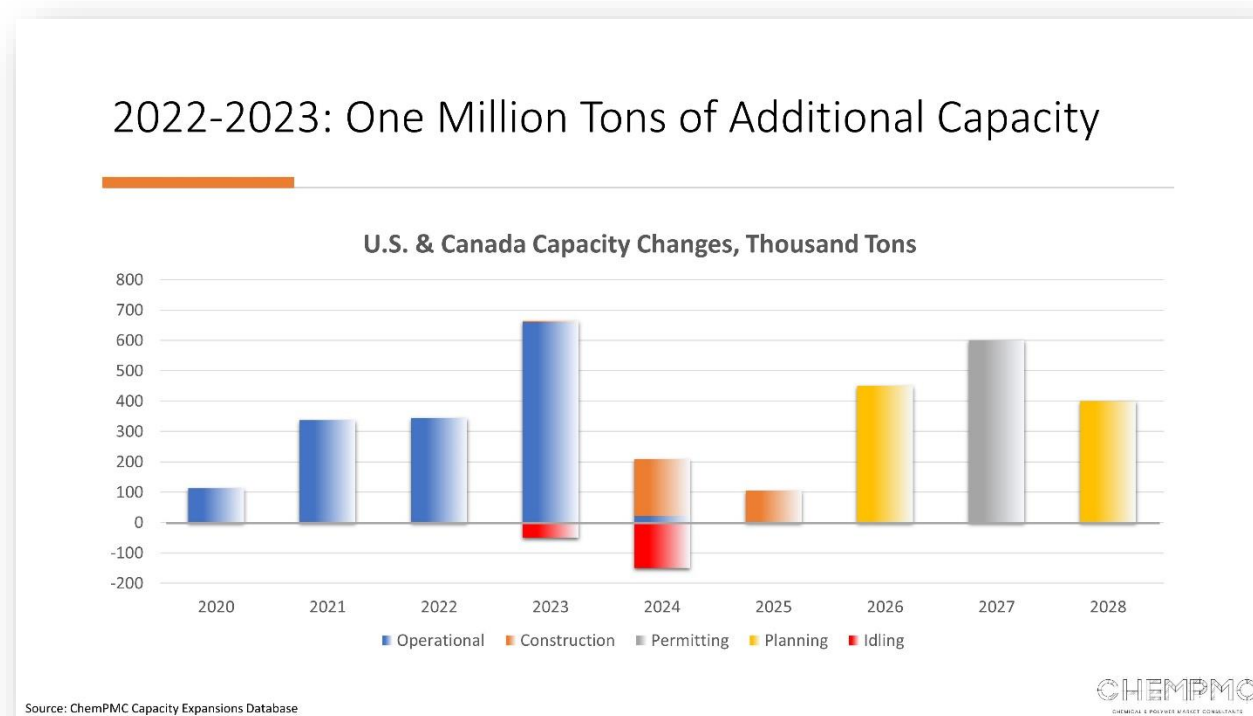
4. Polypropylene Supplies in North America

4.1 Capacity Expanding

During last year's fall conference, we discussed how investments in polypropylene capacity paled when compared to polyethylene investments. That doesn't mean that no investments are taking place.

In the last 24 months, regional polypropylene capacity has expanded by one million metric tons. And, over the next five years, there are enough projects in construction, permitting or planning stages to further increase capacity in the region by approximately 1.75 million metric tons (Figure 11).

Figure 11 - U.S. & Canada Capacity Changes



But expansions are not the only changes taking place regarding capacity in the region. In September of this year, Braskem announced it was idling one of its production lines at its Marcus Hook, Pennsylvania site. It's been reported that this site has faced feedstock constraints since Philadelphia Energy Solution closed its Philadelphia refinery in 2019.

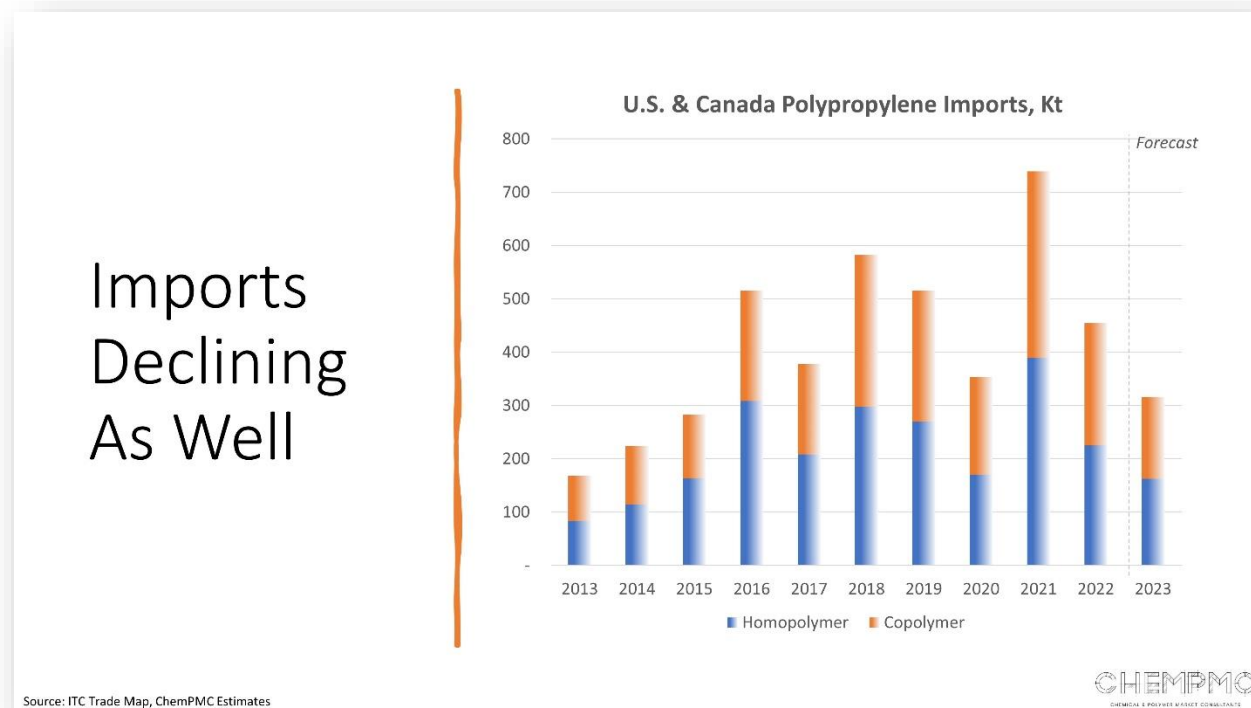
The difficulty of obtaining enough feedstock for this plant, together with the dismal domestic demand evolution, would be the two main drivers for this closure. This is the first closure of polypropylene capacity since 2014, when Flint Hill Resources closed its 90 KT plant in Marysville, Michigan.

Polypropylene production in the U.S. and Canada decreased by 6% in 2022 and, so far, it has declined by a further 2% this year. Again, the negative domestic demand trends in the last couple of years are likely the key cause of the regional production trends.

4.2 Imports Decline

Production is not the only supply component that is declining in North America. After peaking at over 700 thousand tons in 2021, imports dropped to approximately 450 thousand tons in 2022. And, if the year-to-date trends continue, imports will drop again this year to a little over 300 thousand tons, less than half of what they were just two years ago (Figure 12).

Figure 12 - U.S. and Canada Polypropylene Imports



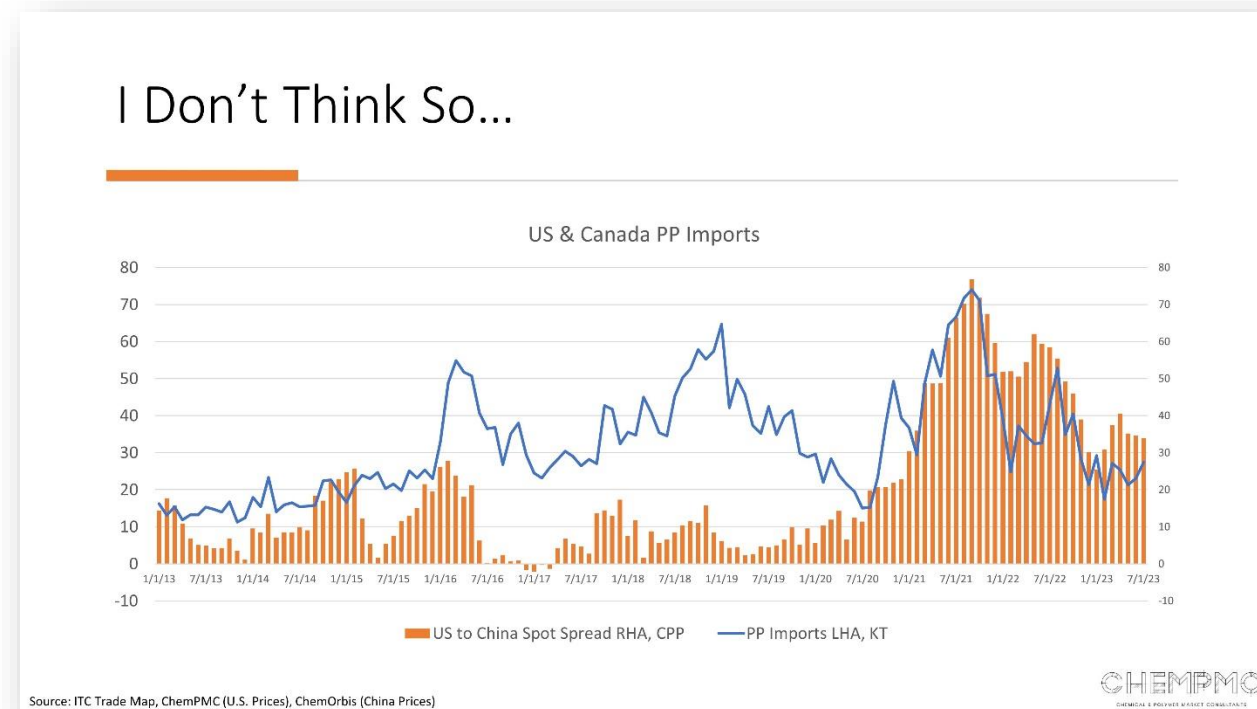
This decrease in imports may seem logical, when we consider what's going on with demand in the region. However, is it the right trend for polypropylene buyers?

I venture to say that I don't think so. To explain where this opinion is coming from, I share with you Figure 13. This chart shows you the monthly delta between U.S. and Asian prices (orange bars), and the corresponding polypropylene imports at the time. (blue line) As you are very aware, polypropylene prices in North America have been quite volatile over the last decade. Volatility was such that, at the beginning of the decade, prices in the region reached spreads to Asian prices that were well above 20 cents per pound.

These large price differentials are called arbitrage. In order to close an arbitrage between regions, economic theory says you need to purchase material from the lower cost region and import it into the high-cost region. This must be done in a sufficiently large quantity to affect the supply and demand balance in either the receiving or the sending region. By tightening the balances in the low-price region, we would help their prices increase. And by increasing the supplies in the high price region, we would help prices decrease.

Initially, imports to North America failed to respond to these spreads. Why was that the case? Importing polyolefins into this region was not easy. To import polypropylene, buyers needed to contend with the risk that came with the length of time between when a product was ordered and when it was received. In addition, overseas products are typically packaged in 25 kg sacks or one-ton super sacks; this required the investment in infrastructure to break the packaged product into bulk. And importing also required the importer to invest in logistical infrastructure, such as railcars, required to move the product from ports into the location where consumption would take place. All in all, a complicated process.

Figure 13 - U.S. & Canada PP Imports Vs. the U.S. to China PP Price Spread



However, the volatility in subsequent years continued, so eventually the required investments to import material into the region took place. And, as we can see in the chart above, imports soared in 2016, to levels not seen before. This helped force the closure of the arbitrage between North America and Asia, bringing regional prices back in line with those around the world. Once the gate was opened, we took advantage of it. Every time that the arbitrage between North America and Asia opened, imports would expand, helping bring prices down. We even did it during the pandemic, despite the horrible logistical challenges that were being faced during that time.

But, as we can see, the U.S. to Asia price spreads remain exceedingly high, and imports are not expanding accordingly. I venture to say this is a mistake. Prices will remain out of line with prices overseas unless someone does something to change the supply and demand balance in the region to the extent that prices in North America align again with global prices. Reducing imports will not do the trick; in fact, it is a move in the wrong direction, that does not benefit polypropylene buyers.

4.3 Green Investments Rising

When we look at the details of the investments that have recently been completed or that are being considered, we can see that two are directly linked to the industry's efforts to provide environmentally friendly solutions.

Figure 14 - Capacity Expansions in North America

| Company | Type of Project | City | State/Province | Technology | Capacity (KT) | Expected Start Up | Status |
|--------------------|-----------------|-------------------|----------------|---------------------|---------------|-------------------|--------------|
| Braskem | New Plant | La Porte | TX | UNIPOL PP | 450 | Oct-20 | Operational |
| Heartland Polymers | New Plant | Strathcona County | Alberta | UNIPOL PP | 525 | Jun-22 | Operational |
| ExxonMobil | New Plant | Baton Rouge | LA | | 450 | Dec-22 | Operational |
| Purecycle | New Plant | Ironton | OH | Purecycle PP | 50 | Jun-23 | Operational |
| Invista | Expansion | Longview | TX | | 45 | Dec-23 | Construction |
| Formosa Plastics | New Plant | Point Comfort | TX | Japan Polypropylene | 250 | Jun-24 | Construction |
| Citroniq | New Plant | Kansas | KS | Novolen | 450 | Jan-26 | Planning |
| Formosa | New Plant | St. James Parish | LA | | 600 | Jan-27 | Permitting |
| Sabir | New Plant | Port Arthur | TX | | 400 | Jan-28 | Planning |

Source: ChemPMC Capacity Expansions Database

On one side we have Purecycle, that in June of this year started its purification plant in Ohio. Purecycle produces clean polypropylene from post-industrial recycled material. The company faced production issues in September and declared force majeure; there is no current information about its production status. The company is planning a second plant to be located in Augusta, GA. Construction activities should begin in the fourth quarter of 2023.

On the other side, Citroniq is proposing the construction of a few renewable polypropylene plants, that would use corn-based ethanol to produce ethylene, which would then be transformed into propylene via metathesis, to finalize polymerizing the propylene to produce PP. This green-based material would be undistinguishable from petrochemical based polypropylene. Braskem is also evaluating an investment to make bio-based polypropylene in the U.S.

What's interesting about these developments is the fact that they are progressing despite the negative demand trends in the region. The current war on plastics, which is being fought on different fronts, demands that the industry conducts investments such as the ones we just described, to ensure our future.

4.4 Supply – So what?

Between 2022 and 2023, polypropylene capacity in North America expanded by one million metric tons. At the same time, production in the region declined. The weak demand situation in the region is the key driver for production trends. And, unfortunately, this year we saw the first capacity closure since 2014.

Imports of polypropylene into North America are declining. We believe this is the wrong move, since prices in the region are much higher than prices in other regions. Imports are one of the ways that those big price differentials can be reduced.

Investments in environmentally friendly production are on the rise. This is happening in spite of the negative demand trends in the region.

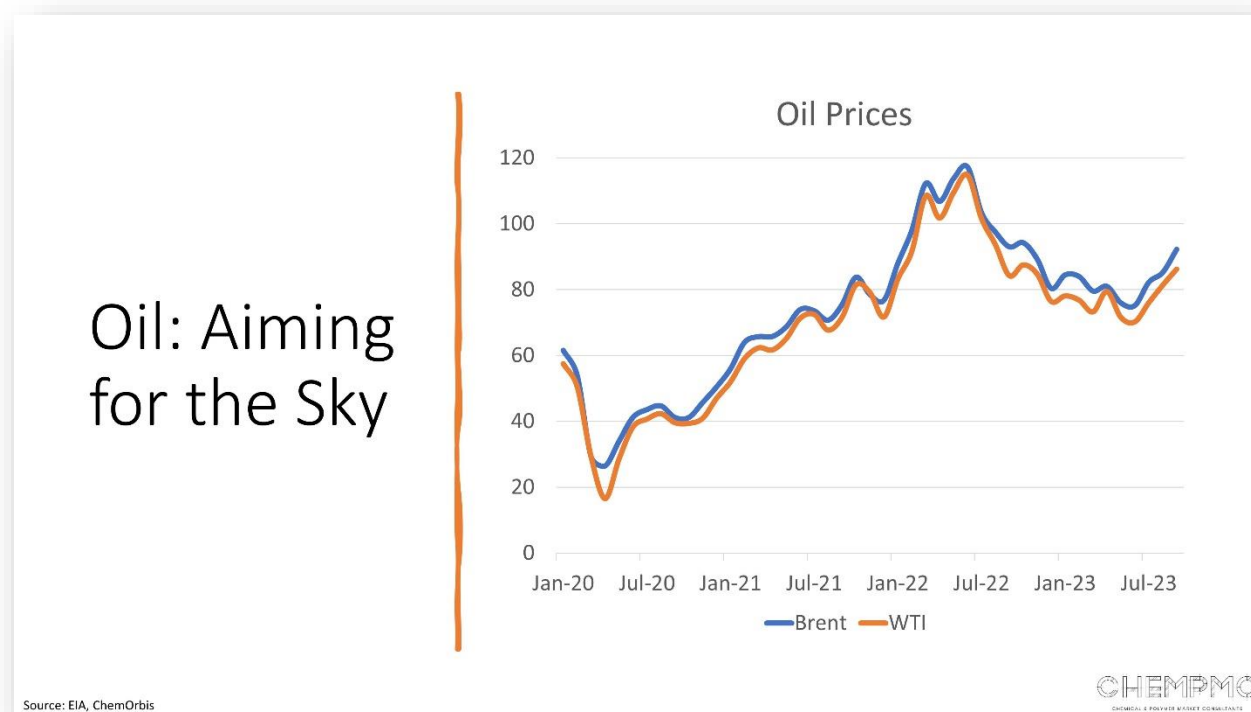
Next subject: Prices.

5. Prices

5.1 Oil Prices and Their Impact on Polypropylene

To analyze the last piece of the puzzle – prices – we are going to go all the way upstream and talk about oil. Starting in June of this year, oil prices have been slowly but surely increasing. We will discuss how this impacts polypropylene, but first I want to explore what may be causing oil prices to move higher.

Figure 15 - Oil Prices (\$/Barrel)



In April, OPEC+, which is an “extended” OPEC including non-member countries like Russia, enacted a voluntary production cut. In addition, Saudi Arabia and Russia enacted voluntary production cuts on top of the ones agreed by OPEC+. Saudi Arabia reduced its production by 1 million barrels per day, and Russia by 300 thousand barrels per day.

These voluntary production cuts by Saudi Arabia and Russia were extended in September into the end of the year. These production cuts, together with resilient global oil demand despite economic headwinds, collaborated to push down global oil

inventories, as we can see in Figure 16. The additional fact that future prices for oil were lower than present prices created a further incentive for producers and countries to sell from inventories.

Figure 16 - Oil Inventories



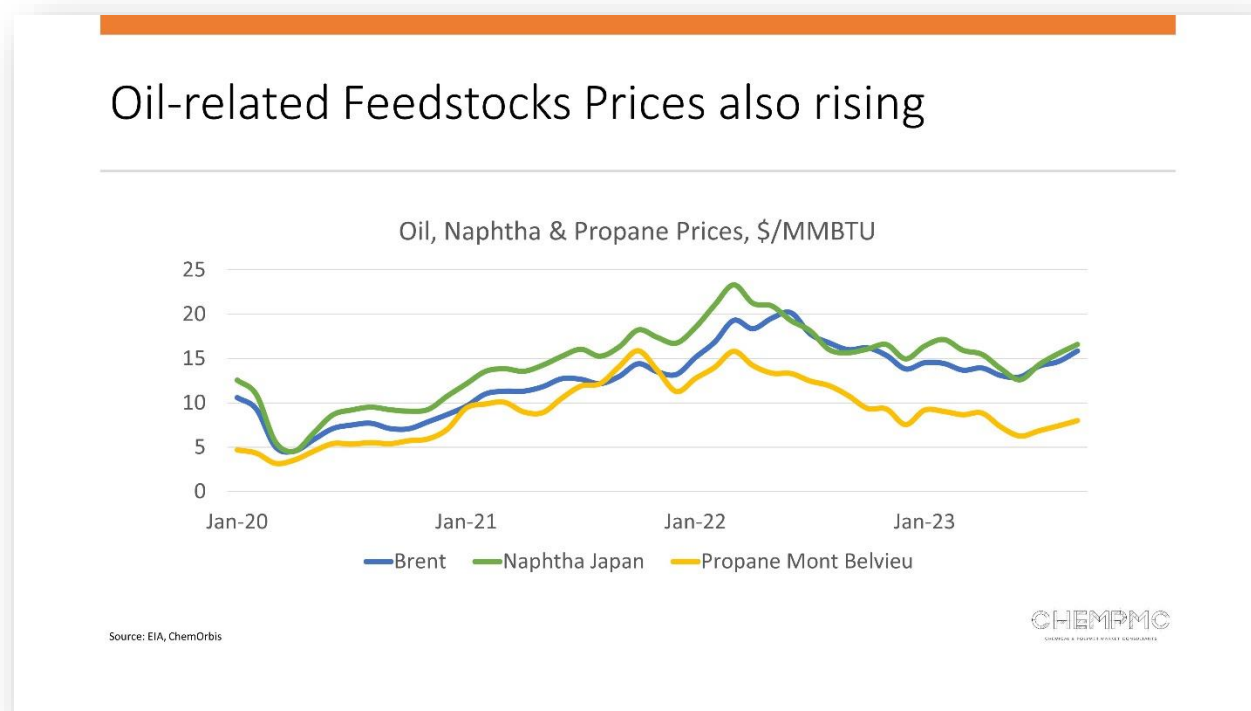
And, as you know with any commodity, tight inventories equal tight markets, which results in higher prices. Saudi Arabia and Russia were the main beneficiaries of the higher oil prices. But high oil prices bring other issues to the table.

First, it causes the dollar to strengthen, making dollar-denominated commodities more expensive. Increased commodity and energy costs counter attempts by economies to tame inflation. As a result, central banks may continue to push rates higher, increasing the risk of a global recession.

Additionally, and specifically for petrochemicals, oil-related feedstocks that are used for petrochemical production are becoming expensive. Naphtha and propane, two feedstocks for propylene production, are impacted by oil prices. And, as you can see in Figure 17, as oil prices move higher, so do naphtha and propane. Prices in this chart are

presented on a common basis (\$/MMBTU, or dollars per energy content) to allow for comparison across commodities.

Figure 17 - Oil, Naphtha & Propane Prices



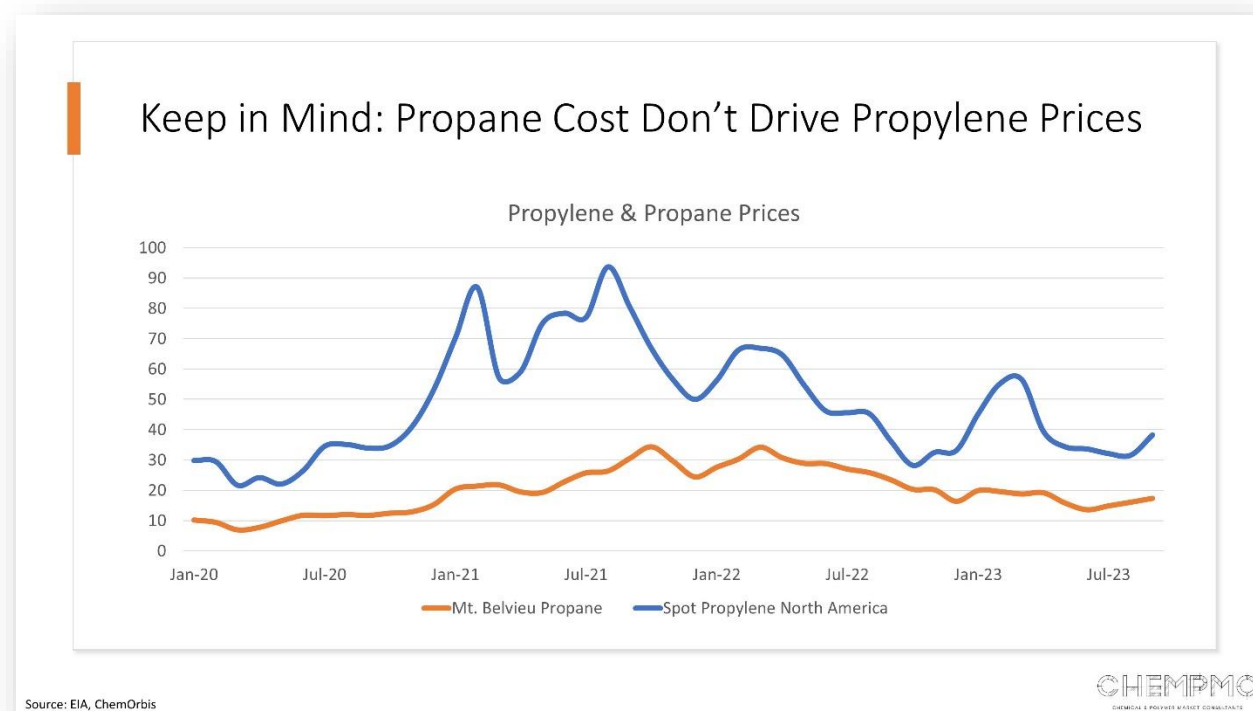
One thing you may notice is that propane prices in North America are relatively low, when compared to oil and naphtha prices. There are specific dynamics in our region that allow for this situation. Specifically, propane inventories in the U.S. are well above the five-year average, helped by a warm 2022/2023 winter. Additionally, we have a limited ability to increase propane exports out of the country from their current level. These two factors help propane prices in North America to remain relatively low.

Nevertheless, as oil moves higher, the floor of polypropylene raw material costs moves higher.

But how exactly do polypropylene prices respond to higher oil prices? It happens on an indirect basis. Let's focus first on propane and its impact on propylene prices. When you analyze Figure 18, it appears that propane prices are not a key driver of propylene prices.

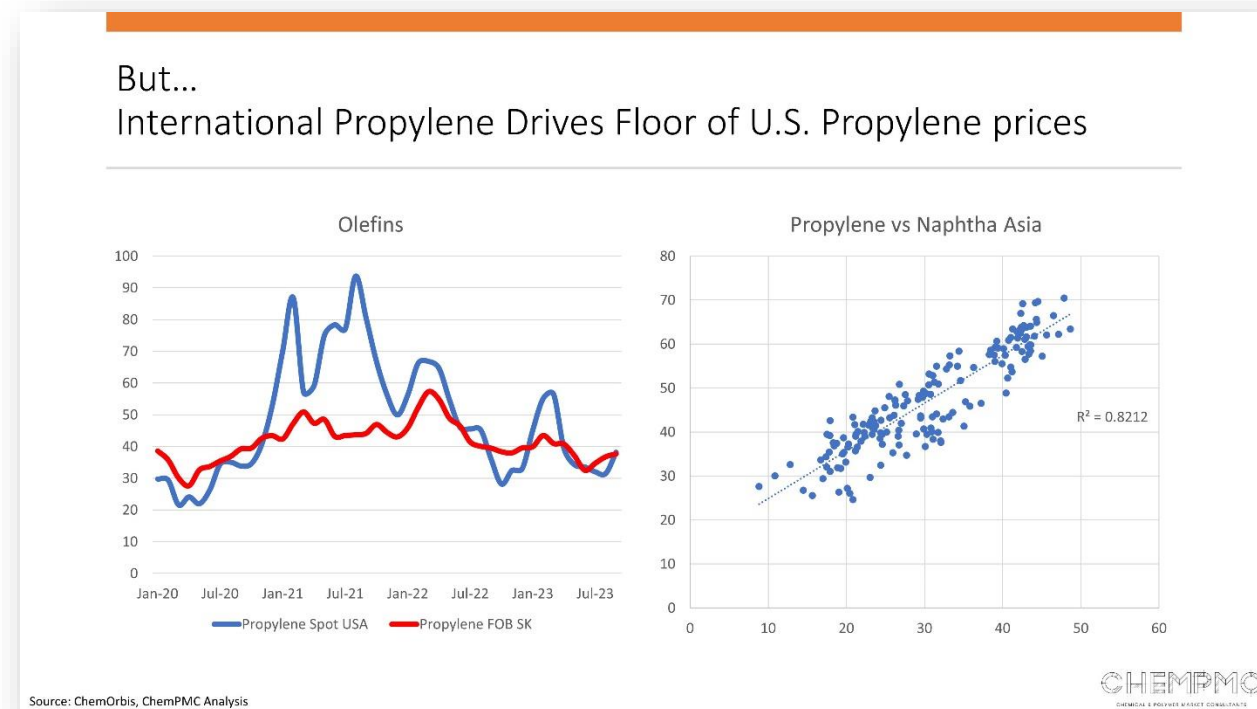
You could say that propane prices draw a virtual line that delimits the bottom of propylene prices, but that would be all.

Figure 18 - Propylene and Propane Prices, Cents per Pound



Now, when we compare propylene prices in North America versus Asia, a more interesting relationship appears. The left chart on Figure 19 shows propylene prices in both regions. As you can see, propylene prices in North America typically don't fall below Asian prices, or at least not on a consistent basis. You can therefore infer that Asian propylene prices drive the floor of U.S. propylene prices. The chart on the right shows the correlation between Asian propylene prices and Naphtha prices. What that chart shows is that 82% of the variability in propylene prices in Asia can be explained by variability in naphtha prices. In simpler terms, as naphtha prices in Asia move, so do propylene prices in Asia.

Figure 19 - Propylene and Naphtha Connection



Therefore, if oil prices move higher, the propylene price floor in North America will rise, increasing polypropylene costs (and its price floor as well).

In the week prior to the FlexForward conference, oil prices seesawed dramatically. Prices were driven down by increased production from countries outside of the OPEC+ group, and rose in response to the Hamas terrorist attacks in Israel and the consequent war between Israel and Hamas. But our message remains – as oil prices move up or down, polypropylene cost will move up or down, and with it the floor of polypropylene prices in the region.

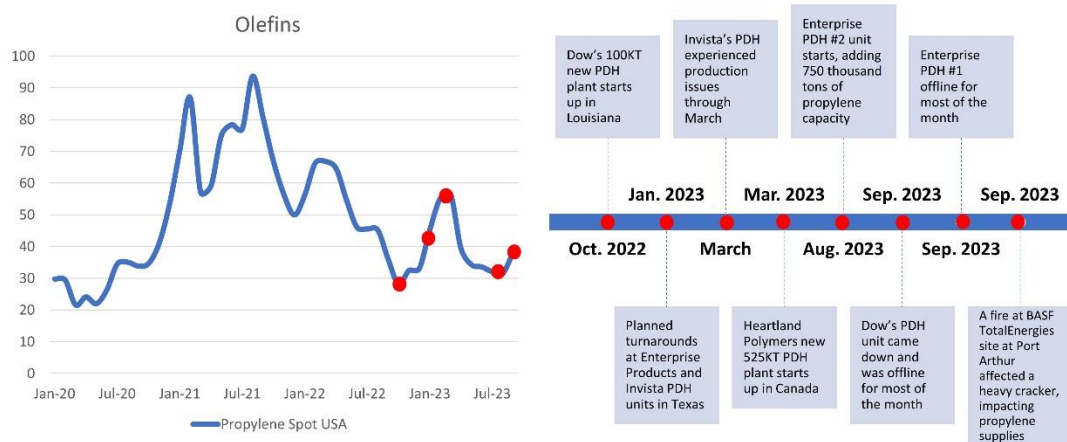
5.2 Supply Events Impact on Prices

So, if oil influences the underlying trend (floor) of prices, what drives the volatility in polypropylene prices? For that, we need to understand how supply events affect prices. Instead of theories about the link between supply events and prices, let's just look at the

evolution of propylene prices since the end of 2022 and what events may have happened that could have influenced them.

The first class of supply events I want to call attention to are turnarounds. In January of 2023, Enterprise and Invista both conducted planned turnarounds in their PDH units. As that was happening, we can see propylene prices starting to increase. Invista's PDH experienced production issues through March, helping push propylene prices higher. By March, Heartland Polymers started its PDH unit in Canada. This, together with the end of Invista's production issues, improved supplies and helped bring prices down. By August, prices reached a low, as Enterprise started its 2nd PDH unit. Prices did not continue to fall, since production issues at Dow and Enterprise PDH #1, as well as a fire at BASF TotalEnergies refineries, tightened supplies. Tighter supplies and higher oil prices then drove prices up in September.

Additionally... Events Impact Propylene Price Swings

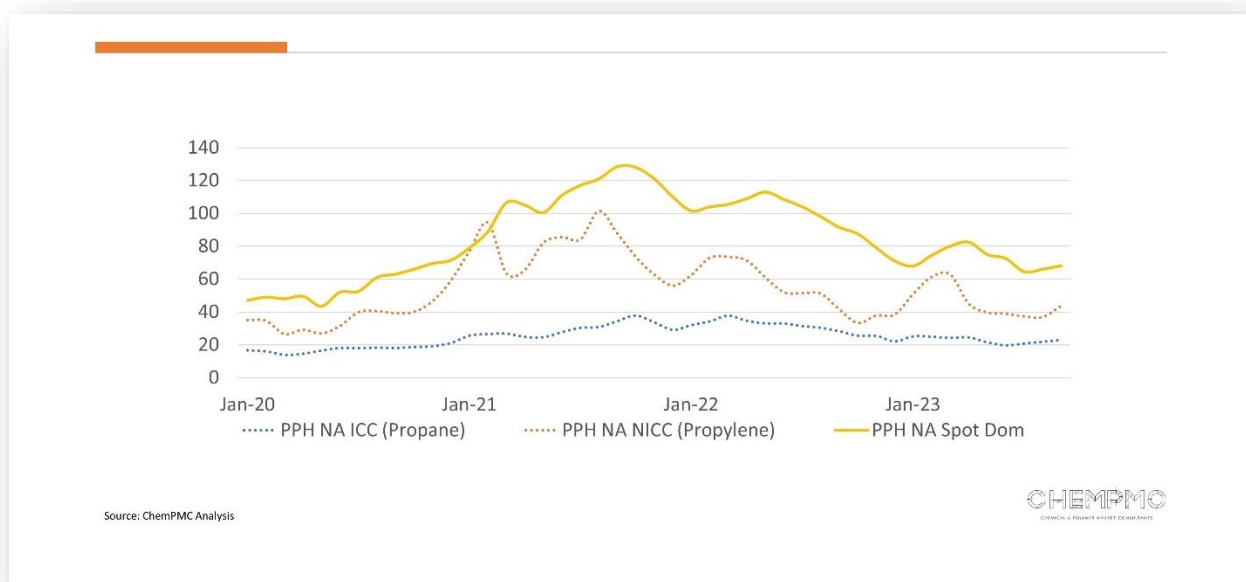


Source: ChemOrbis, ChemPMC Analysis

In general, polypropylene prices in the region track propylene prices, with a slight delay. This is evident when you look at Figure 20, and compare the polypropylene price trends with the non-integrated cash costs, which use propylene prices as the basis for calculation. So, as supply issues impact propylene prices, polypropylene prices respond.

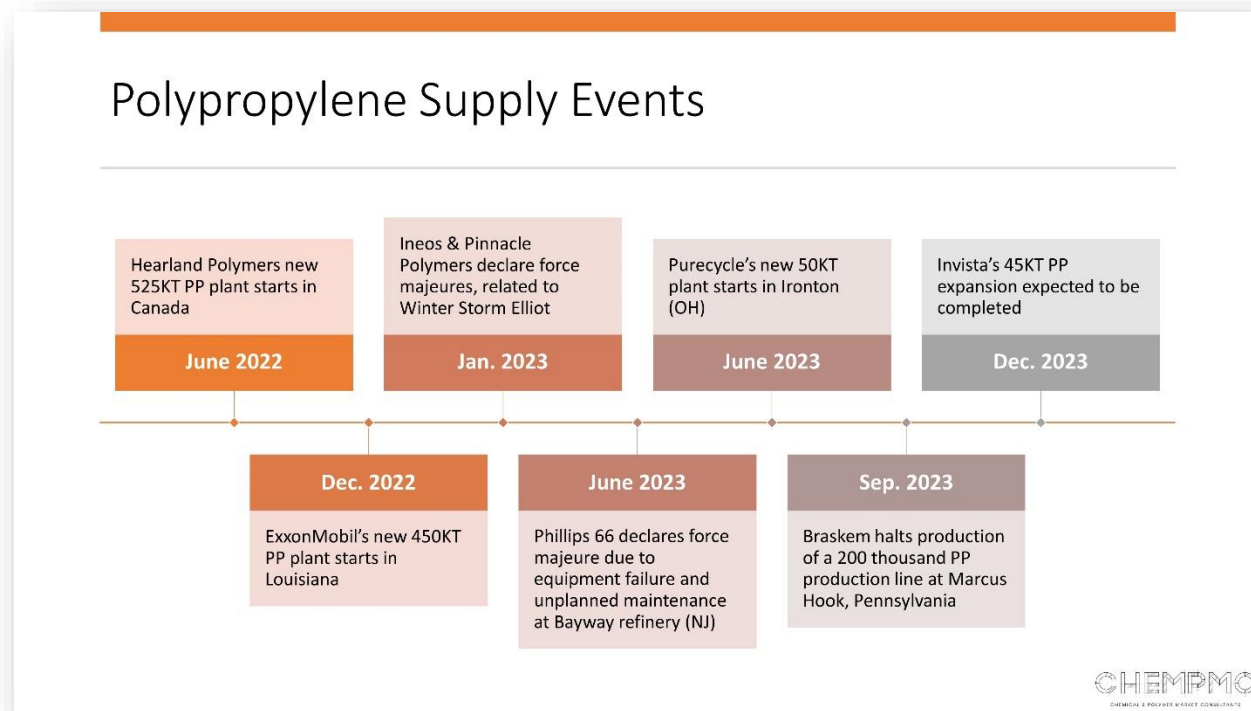
It is evident from the same chart that integrated costs to propane have little effect on polypropylene prices.

Figure 20 - Polypropylene Homopolymer Prices and Costs (cents per pound)



But that's not all. Polypropylene prices are also impacted by supply events in the polypropylene side of the value chain. Whether it is increases in product availability brought about by new plants, weather events or planned (or unplanned) maintenance in polypropylene plants, all affect the supply and demand balance and can have an impact on price trends.

For a list of polypropylene-related supply events, see Figure 21.

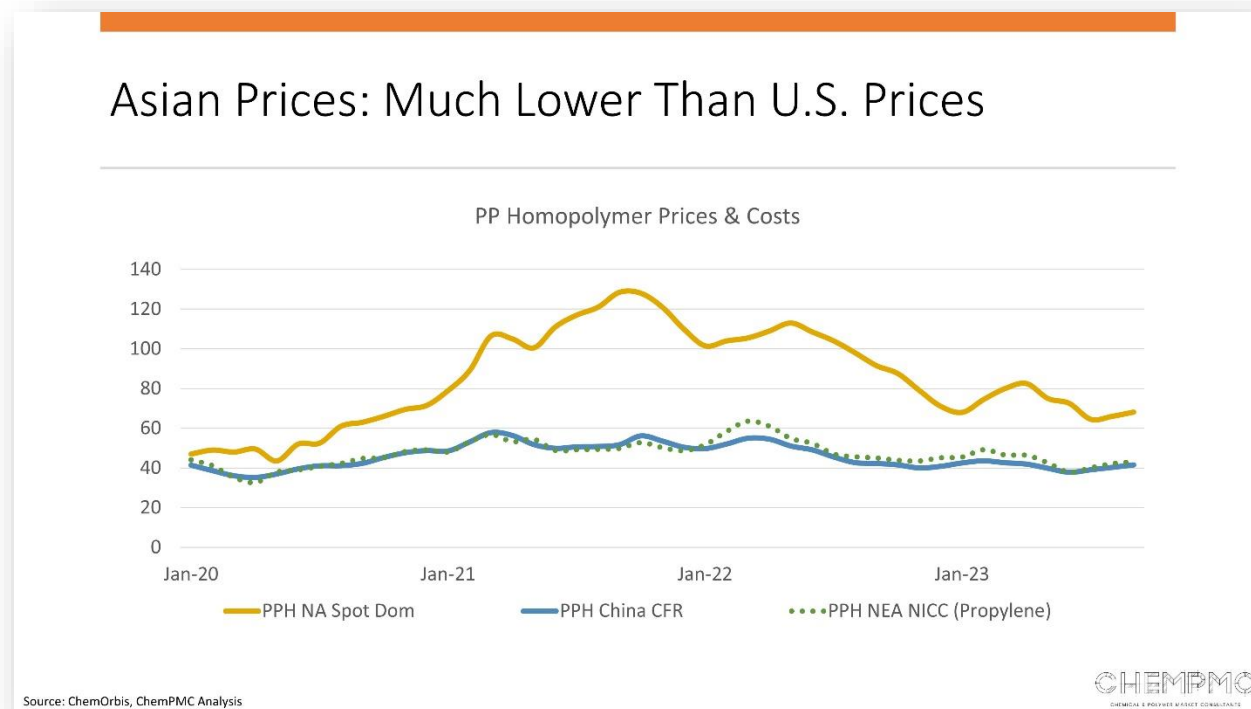
Figure 21 - Polypropylene Supply Events

The message is simple. You must pay attention to what's going on with production issues in the propylene to polypropylene value chain, to help you determine which direction polypropylene prices may be headed on a short-term basis.

5.3 Three final comments on Prices

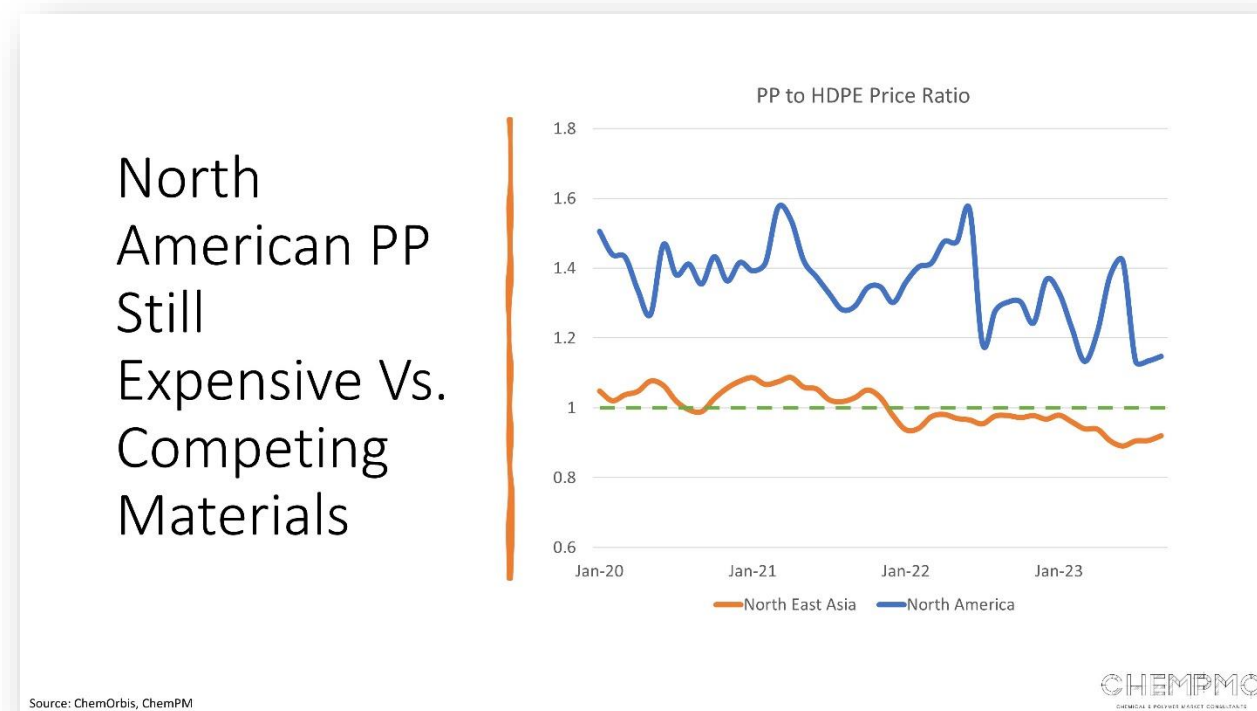
There are three final price-related areas we wanted to discuss. First, how much higher are U.S. prices versus prices in Asia. As mentioned earlier, since the beginning of the last decade, we have seen periods in which U.S. prices temporarily split from global prices. However, as Figure 22 shows, prices in the U.S. separated from prices in Asia in early 2021. And even though the spread has declined since peaking in October of 2021, it remains quite high when compared to historical levels. From our point of view, unless converters act and start bringing material from less expensive regions, this spread will be very hard to correct.

Figure 22 - PP Price Comparison - U.S. Vs. Asia (cents per pound)



The second aspect to highlight is how polypropylene in the U.S. remains quite expensive versus competing materials. Figure 23 shows the ratio of polypropylene to high density polyethylene (HDPE) prices in Northeast Asia and in North America. In Asia, the ratio has fallen below 1, meaning polypropylene is cheaper than HDPE. This is reflective of a PP oversupply situation in that region. On the other hand, the PP to HDPE ratio in the U.S. hovers at around 20%. The danger in this case is that being more expensive may impact future demand growth for polypropylene in the region. Faced with the choice between two materials that offer the same performance, converters may choose the cheapest solution for future packaging developments. This is less of a concern if you are a converter, but more worrisome for producers. The health of future investments and of the PP industry in general hinges on the future growth of demand.

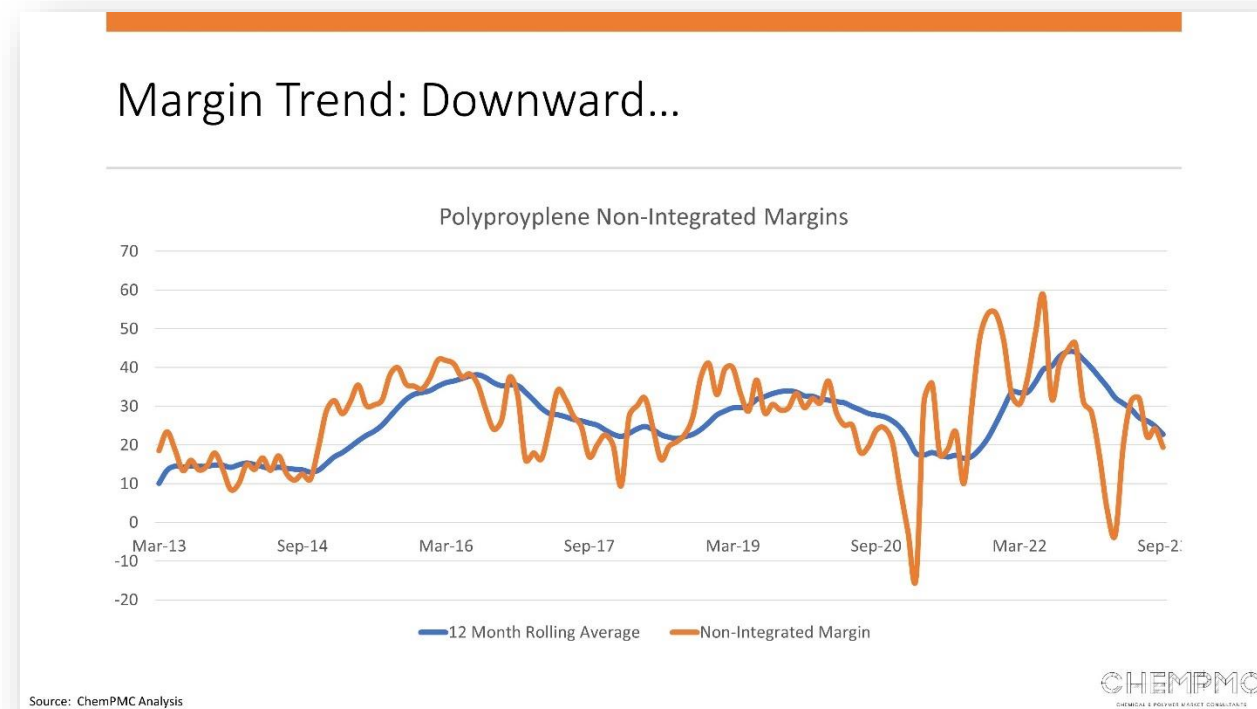
Figure 23 - PP to HDPE Price Ratios



Finally, we wanted to highlight the negative trend in margins for polypropylene producers. The industry has enjoyed a few years of relatively healthy polypropylene margins. There is always cyclical in the industry, but the lowest level that margins trends have experienced since 2014 has been approximately 20 cents per pound. Now, since November of 2022, margins have been on a negative trend that continues to be quite steep (Figure 24). Note that these margins are calculated on a non-integrated basis (buying propylene at merchant prices); margins are much better for PDH-integrated producers.

Nevertheless, the negative demand trends in the region, together with the global oversupply situation for polypropylene, don't bode too well for the future of PP profitability. We expect producers will do everything in their power to stem the negative trends in margins. But it will be a hard fight, with lots of cheap material available overseas, ready for those converters intrepid enough to look for alternative supplies.

Figure 24 - Polypropylene Non-Integrated Margins (cents per pound)



5.4 Prices – So What?

What are the key things to remember about prices?

First, oil prices remain volatile but are in general trending higher. Higher oil prices raise the price floor for propylene and polypropylene. The same can be said of the opposite – lower oil prices would result in a lower price floor for propylene and polypropylene.

Events that affect supplies have an impact on propylene and polypropylene prices, particularly short-term price volatility. Turnarounds, new plants, weather events are all going to potentially affect the short-term trends in prices.

Producer margins in the region are trending lower. Prices in North America are higher than those in Asia. And polypropylene in North America remains expensive versus other competing materials.

6. Looking at the Crystal Ball

What about the future? By now you should have a better understanding of the different pieces of the polypropylene puzzle. We are now going to look at potential directions that some of these puzzle pieces may take, and how they can impact future prices for polypropylene. The idea is to empower you to foresee where prices may be headed in the region, when faced with different circumstances.

The analysis is going to come in the shape of memory cards; cut them, take them with you, and keep them in mind the next time you are going to negotiate prices.


Let's Talk About The Future...

- Oil Trending Higher
 - Feedstock costs (naphtha, propane) to increase
 - *PP Price floor to increase*
- Oil Trending Higher
 - Increased risk of global recession
 - Demand negatively impacted
 - Margins under pressure
 - *PP Prices to decrease*



Let's Talk About The Future...

- Improved propylene supplies
 - Lower propylene prices
 - Lower non-integrated cash costs
 - *Lower polypropylene prices*
- Planned propylene turnarounds
 - Decreased propylene supplies
 - Higher propylene prices
 - Higher non-integrated cash costs
 - *Higher polypropylene prices*



Let's Talk About The Future...

- Expensive polypropylene
 - Future demand growth impacted
 - Future demand destruction
 - *Lower prices*
- Closure, High-cost polypropylene plants
 - Tighter supplies
 - *Helps arrest negative price trends*



Let's Talk About The Future...

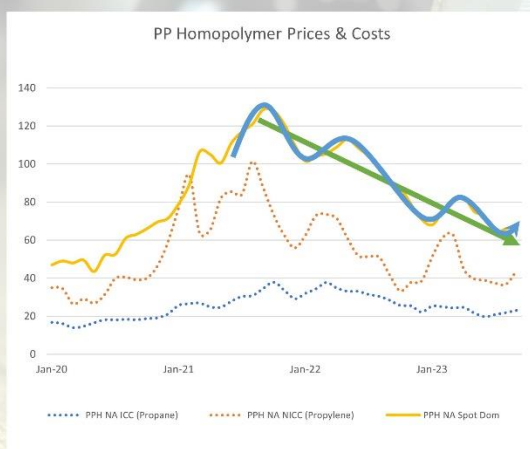
- Unplanned production issues (weather, other causes)
 - Decreased polypropylene supplies
 - *Higher polypropylene prices*
- China Increasingly Self Sufficient
 - Increasingly competitive exports markets
 - *Lower polypropylene prices*



Ok, so I bet you still want to know what we are thinking of the future.

Well, here we go. We believe that the long-term trend for prices is for them to move and remain lower than they are currently. This should be true for the balance of 2023 and probably at least through 2024. That said, we fully expect prices to be highly volatile, impacted by any number of supply issues. Some of those supply issues are harder to predict (weather events, for example). Others are regular and you should be aware of when those happen (turnaround seasons, for example).

What To Make Out of It?



Long term trend: Lower Prices

Short term: Volatile Prices, impacted by supply factors

Source: ChemPMC Analysis

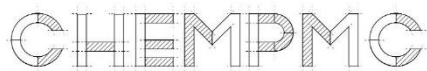
7. In Summary

Changes in consumer trends are affecting polypropylene demand. U.S. producers have been able to increase their exports tremendously, but those increases in exports have not been sufficient to compensate for the losses in demand in the region. What's more, China is no longer the market of last resort for global polypropylene producers. We are therefore in a global oversupply situation for polypropylene.

Capacity in the region is expanding, even environmentally friendly options. On the other hand, production is being affected by the trends in demand in the region. As a result, plants closures are starting, after almost a decade without seeing them.

Polypropylene remains expensive versus other competing polymers. This affects the long term growth prospects for the material.

Higher oil prices are driving up the floor for propylene and PP prices. Supply-related events are causing short-term volatility. Margins for producers are trending down. As a result, we expect short-term volatility, but long-term (12 to 24 months) the overall trend would be for prices to move and remain low.



Chemical & Polymer Market Consultants

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